RESPONSE OF LENTIL TO RHIZOBIUM IN A SEMIARID ENVIRONMENT

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INTRODUCTION

The area seeded to lentil (*Lens culinaris* Medik.) in the northern Great Plains has increased steadily in the past 15 years, and this annual legume is being used to diversify cereal-based crop rotations, replace conventional summerfallow and conserve soil quality, and enhance productivity of subsequent cereal and oilseed crops. Like most annual legumes, lentil can provide a part of its own N requirement through symbiotic N_2 fixation when the plants are inoculated. Most producers in the northern Great Plains inoculate the seed or the soil with a rhizobial strain either in peat powder or granules. However, little is known about the effect of formulation and placement of inoculants in the soil on lentil production under semiarid growing conditions.

OBJECTIVE

The objectives of this study were to determine (i) the effect of rhizobial inoculant formulations and the methods of placement in soil on lentil establishment, maturity, and seed yield under semiarid environments, and (ii) the performance of inoculants on lentil roots under silt loam compared to heavy clay soils.

MATERIALS AND METHODS

Field experiments were conducted on a silt loam soil at Swift Current and on a heavy clay soil at Stewart Valley, in Saskatchewan, Canada from 2000 to 2002. Two formulations of rhizobial inoculants were peat-based powder applied to the seed and granular inoculants applied to the soil). Also, granular inoculants were applied in the seed-row compared with side-banding practices. Seeds of ‘Laird’ and ‘CDC Glamis’ were inoculated with peat-based powder at the rate of 4 g kg^{-1} of seed. For soil inoculation treatments, granules were applied to the soil at the rate of 5.6 kg ha^{-1}. The two formulations of inoculants contain identical *Rhizobium* strains, with a minimum of 100 million viable cells of *Rhizobium leguminosum biovar vicea* per gram. In the side-banding treatments, the inoculant was placed 4 cm to the side of the seed row.

The fields had no legume crops grown in the previous five years. Plots were seeded directly into wheat stubble using a 2-m wide hoe press drill. Each plot was 7.5 m long and consisted of 8 rows with 25-cm row spacing. At maturity, the centre six rows of each plot

($9.0\ m^2$) were harvested with a plot combine and the seed samples were air-dried, cleaned, weighed, and seed yield presented on a dry basis.

RESULTS AND DISCUSSION

On average, the lentil crop required 52 days or 414 units of growing degree-day (GDD) to reach 1st flower, 68 days or 630 GDD to mid-flower, and 94 days or 1044 GDD to full maturity.

Plant density ranged from 67 to 115 plants m^{-2} with the highest density being in 2001 at Stewart Valley and lowest in 1999 at Swift Current. Within a given site-year, there was no significant difference in plant density among treatments, suggesting that inoculation have no direct impacts on plant establishment of lentil in this semiarid region.

Lentil reached full maturity 94 days after seeding on average, but in 2001 severe drought advanced maturity by 3 days and shortened plant height by 20% from the average. Consequently, seed yield in 2001 was only 25% of the yield obtained in other years at Swift Current and was 38% as high at Stewart Valley.

Lentil crop matured 1.5 to 2.7 days earlier when the crop received no inoculants compared to those inoculated with granular inoculants. The early maturity of non-inoculated lentil was probably due to earlier depletion of available soil nutrients on the heavy clay and due to water limitation on the silt loam.

The use of inoculants increased lentil seed yields by 45% averaged across the six site-years, and in 4 of 6 site/years the increased seed yield was due to increased seed mass. Between the two formulations of inoculants, the granular soil inoculants increased the seed yields by 3 to 38% in 5 of 6 site-years compared to seed-applied inoculants.

Inoculated plants produced 9.6 nodules $plant^{-1}$ with nodule dry mass of 9.2 mg $plant^{-1}$, which were, respectively, 92 and 76% greater ($P<0.01$) than those measured on lentil that was not inoculated. Plants with granular soil inoculants produced 12.6 nodules $plant^{-1}$ with nodule dry mass of 11.9 mg $plant^{-1}$, which were 47 and 45%, respectively, greater ($P<0.01$) than those measured on lentil with seed-applied inoculants.

Responses of lentil to inoculants were stronger and more consistent on the heavy clay at Stewart Valley than those on the silt loam at Swift Current. The use of inoculants increased the seed yield of lentil by an average of 15% at Swift Current, while it was 70% at Stewart Valley. Similarly, on the clay soil, soil inoculation increased lentil seed yield by 26% over seed inoculation, while on the silt loam, soil inoculation performed similarly to seed-applied inoculation (only 2% difference in yield).

CONCLUSIONS

Indigenous populations of *Rhizobia* exist in the soils of the semiarid northern Great Plains, but these indigenous populations apparently are not sufficient to induce effective N_2

fixation in lentil. The use of rhizobial inoculants in lentil significantly increased seed yields (15-45%) compared to non-inoculated crops. Granular soil inoculants outperformed seed-applied inoculants in seed yield (2-26%), with granules placed in the seed-row performing similarly to side-banded granules. Lentil grown on a heavy clay soil responded to inoculants more strongly and consistently than lentil on a silt loam soil. Use of granular soil inoculants may result in a more uniform distribution of *Rhizobium* in the root zone, a more effective nodulation, and increased seed yield.

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